



Waste is a terrible thing to mind—recycle.

Bumper sticker

Forum

Children of Chernobyl

In the aftermath of the April 1986 explosion of the Chernobyl nuclear power plant in the Ukraine, incidence rates of childhood cancers, especially of the thyroid, have been dramatically increasing. The United States agreed this past May to join with the Ukraine to study the effects of radiation exposure on childhood thyroid cancer.

The accident at Chernobyl is the only full-scale meltdown of a graphite core in a nuclear energy station that has ever occurred. It released radioactive material over parts of the former Soviet Union, Eastern Europe, Scandinavia, and later, Western Europe, killing 31 and hospitalizing 300. Scientists predicted that it would lead to an undetermined number of future cancer deaths over a large area.

In particular, the independent nation of Belarus, northwest of Ukraine, where more than two million people were exposed to radiation from Chernobyl, has recorded steadily increasing numbers of cancer incidences and congenital malformations and illnesses. "At first people did not want to link these medical problems with Chernobyl, and many accused us of radiation phobia," Yevgeny Konoplya, director of the Radiobiology Institute of Belarus's Academy of Sciences and an expert on post-Chernobyl effects, told the *Washington Post*. "But now they know. All the problems they faced in

Nagasaki we face here. There was no place as hard hit by Chernobyl as Belarus."

In 1986, there were 2 cases of thyroid cancer in children under 14 in Belarus, but by 1994 there were 82 registered cases. According to the *Washington Post* article, at the Borovlyani cancer institute outside Minsk, more than 50 children are now being treated for brain tumors, bone tumors, kidney tumors, and other cancers.

Since the collapse of the Soviet Union, independent nations have lacked funding to support such widespread public health problems. Therefore, the United States has agreed to step in and help. The U.S. Department of Energy announced this past spring that it will work with the government of Ukraine to establish an international nuclear safety and environmental research center at Slavutich near Chernobyl.

Efforts to establish the center are a result of a collaboration between the State Department, the DOE, the Nuclear Regulatory Commission, and Ukrainian nuclear and environmental agencies and organizations. "This action is a significant step toward establishing a Center of Excellence to improve the safety of nuclear energy generation in Ukraine, and reduce the risks posed by Chernobyl reactor operation, Secretary of Energy Hazel R. O'Leary said in a press release. "The center will also serve as a focal point for international environmental

research in the areas of environmental contamination and site restoration." The DOE will spend about \$3 million over the next two years to establish the center. These funds are part of a \$38 million international effort to clean up Chernobyl.

In addition to establishing the center, the DOE and the NRC plan to provide funding for the National Cancer Institute to lead studies on the effects of radiation exposure on childhood thyroid cancer. Over the next 15 years, the DOE and the NRC will provide \$1 million annually for researchers to regularly test about 70,000 children exposed to radiation from the accident. The researchers will compare their findings to data gathered from children in the weeks following the accident. They hope to determine the extent to which radioiodine, especially iodine-131, causes thyroid cancer and the role of possible cofactors such as iodine deficiency, according to the DOE.

Health Effects of DDE

In one of those serendipitous events that sometimes lead to scientific breakthroughs, researchers attending a lecture late last year by University of Florida biologist Louis Guillette on developmental problems in male alligators realized they were seeing similar effects in laboratory rats recently exposed to a fungicide. The ensuing discussion spurred research that may illuminate how environmental agents act like hormones to disrupt development and possibly cause cancers.

Guillette reported that the alligators had been exposed to DDT, a hazardous pesticide that he said acts as an environmental estrogen. Too much estrogen, Guillette stated, resulted in an imbalance of androgen in the alligators, causing developmental defects. William Kelce and L. Earl Gray, biologists at the EPA's Health Effects Research Laboratory, guessed, however, that DDT was really acting as an anti-androgen.

Kelce and Gray had just published a paper in the June 1994 issue of *Toxicology and Applied Pharmacology* detailing how the fungicide vinclozolin demasculinized rat pups by altering the action of the male hormone testosterone. Vinclozolin blocked normal hormonal function by binding to the androgen receptor. The fungicide bound loosely enough that the receptor was not acti-



Operation Belarus

Little people, big effects. The children of Belarus may bear the biggest brunt of adverse health effects from the accident at Chernobyl.

vated, however, and therefore could not signal transcription of androgen-dependent genes, which disrupted sexual development. Vinclozolin was the first chemical reported to have an anti-androgenic effect.

The EPA investigators and molecular biologists from the University of North Carolina at Chapel Hill began to compare their data with Guilette's and months later invited Guilette to the EPA to examine the results. The team found that DDE, the primary metabolite of DDT, shrunk sex organs in male rats by up to 20% in four days. And pregnant rats exposed to DDE gave birth to male rats with female sexual characteristics.

Guilette and the rest of the scientific world were surprised by the results, published in *Nature* on June 15. "There was quite significant binding that helps explain what we saw in the alligators," says Guilette. "I'm rethinking the whole concept of hormone receptor specificity. It's much more complex than we realized." Guilette noted that because some minor isomers of DDT are clearly estrogenic, DDT and its metabolites are now known to affect both estrogenic and androgenic hormone action.

DDE's anti-androgenic effects may help explain recent adverse changes in male reproductive health, such as decreasing sperm counts in various parts of the world, and increases in testicular cancer and cases of abnormal development of the penis and testis. The work also raises the question of how chemicals can act simultaneously as agonists and antagonists for both estrogen and androgen, says Kenneth Korach, an NIEHS researcher who was involved in creating an estrogen knock-out mouse. Elizabeth Wilson, a University of North Carolina at Chapel Hill investigator working with Kelce, is researching whether the androgen receptor forms a heterodimer, binding both DDE and androgen. The dose response of DDE would be critical in this case, she says.

Although DDT was banned in the United States in 1973, DDT and its metabolites persist in the environment (it has a half-life of up to 100 years), and it is still used to control malaria in some countries such as Mexico and Brazil, and in some areas of Africa.

The EPA/UNC team reported that the concentration of DDE needed to inhibit androgen receptor transcriptional activity in cell culture or to affect newborn rat pups is analogous to levels found in other instances of DDT contamination including Guilette's Florida alligator eggs and in kidneys of still-born babies in the United States in the mid-1960s, when DDT was still being used.

Scientifically, the study offers more questions than answers. It raises the issue of the adequacy of testing manufactured chemicals

EHPnet

In war and football, it's often said that the best defense is a good offense. This same philosophy is the basis for a World Wide Web site aimed at improving the environment through pollution prevention. Enviro\$ense (URL:<http://wastenot.inel.gov:80/envirosense/>), which is maintained at the Idaho National Engineering Laboratory, is funded by the EPA and the Strategic Environmental Research and Development Program (SERDP), a joint effort of the Department of Defense, the Department of Energy, and the EPA that supports environmental quality research, development, demonstration, and applications programs.

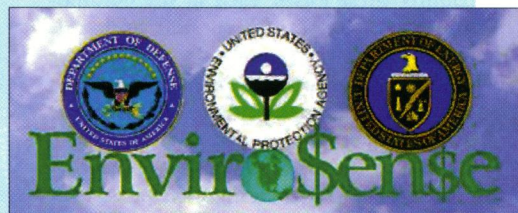
Eight hyperlinks on the Enviro\$ense homepage offer a vast array of information in categories such as news and resources, pollution prevention programs from the local to the federal level, international programs, technical research and development, compliance and enforcement, and more.

For example, the news hyperlink connects users to information such as a Pollution Prevention Directory, several hotlines and clearinghouses, the National Consortium for Environmental Education and Training's Environmental Education Link (a gopher site that offers access to teaching resources including instructional materials, articles, databases, and grant information), and the National Pollution Prevention Center for Higher Education.

Federal laws, regulations, environmental activities, and presidential executive orders, and both state and local pollution prevention servers may be accessed through another hyperlink. The international resources hyperlink provides information on pollution prevention programs around the world by connecting to organizations such as the U.S. Agency for International Development's Environmental Prevention Protection Project, the Montreal Protocol (protection of ozone layer), the North American Free Trade Agreement, the Organization for Economic Cooperation and Development, and the United Nations Environment Program.

The technical research and development hyperlink provides access to case studies and fact sheets on EPA studies of commercial companies, as well as environmental research briefs, project summaries, and pollution prevention assessments. This link also connects to the EPA Office of Research and Development and a pollution prevention publications bibliography.

Perhaps the most innovative element of the site is an interactive search function that allows users to query the Solvent Alternatives Guide (SAGE), the Hazardous Solvent Substitution Data System (HSSDS), and the Department of Defense Pollution Prevention Technical Library. SAGE is a logic-tree system that evaluates a manufacturer's current operating scenario and then identifies possible alternative surface-cleaning solvent chemistries and processes that best suit the operating and material requirements. HSSDS is an on-line system of information on alternatives to hazardous solvents that contains product information, material safety data sheets, and other related information. Also available on this site is access to the Department of Defense Ozone Depleting Chemical/ Substance Information.



for hormonally active compounds. "Past regulatory testing was insensitive to these kinds of problems," says Kelce. "We are only now beginning to appreciate what tests need to be conducted."

Guilette also wonders about the effect of an anti-androgen on females: "If it modifies the estrogen-androgen ratio in women, increasing their estrogen, it could result in increased breast cancer and like diseases." Kelce says he has identified 20 other chemicals that have anti-androgenic effects. Although he says he can't release the list yet, he indicated that none of them is currently banned.

The Immortality Enzyme

Telomerase, an enzyme that gives some cells a permanent stay of execution, appears to play a role in lung cancer progression, according to a study in the June 25 issue of the *Journal of the National Cancer Institute*. Jerry Shay and his colleagues at the University of Texas Southwestern Medical Center at Dallas and at the Hiroshima University School of Medicine found telomerase activity in approximately 80% of the 136 primary lung cancer tissues they tested, versus only about 4% of 68 adjacent normal tissue samples. Of the 136 primary lung cancer samples, all 11 of the small cell lung can-